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An Overview of Nanotechnology

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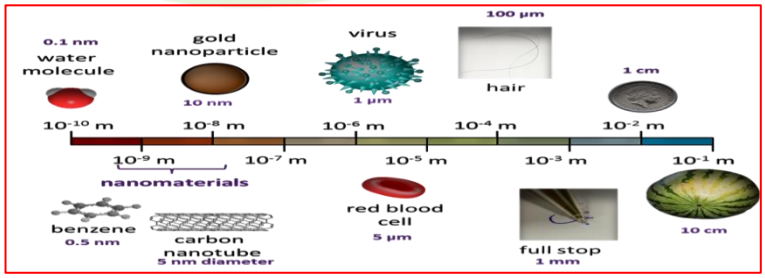
Abstract

The word 'nano' refers to a Greek prefix that means 'dwarf' or anything exceedingly little, and represents one thousand millionth of a metre (10^{-9} m) and technology is the making, usage and knowledge of tools, machines and techniques in order to solve a problem or perform a specific function. Nanotechnology refers to the branch of science and engineering devoted to designing, producing, and using structures, devices, and systems by manipulating atoms and molecules at nanoscale, i.e. having one or more dimensions of the order of 100 nanometres (100 millionth of a millimetre) or less.

According to Royal Society, "Nanotechnology is the design, characterization, production and application of structures, devices and systems by controlling shape and size at nanometer scale". Nanotechnology deals with structures sized between 1-100 nm. Nanotechnology is the study of manipulating matter on an atomic scale.



History of Nanotechnology

The American physicist and Nobel Prize laureate **Richard Feynman** introduce the concept of nanotechnology in 1959. During the annual meeting of the American Physical Society, Feynman presented a lecture entitled "There's Plenty of Room at the Bottom" at the California Institute of Technology (Caltech). His lecture is also published in 1961 in a book "Miniaturization" as a final chapter. He is considered as father of Nanotechnology. Almost 15 years after Feynman's lecture, a Japanese scientist, **Norio Taniguchi**, was the first to use "nanotechnology" to describe semiconductor processes that has been occurred on the order of a nanometer. He mentioned that nanotechnology consisted of the processing, separation, consolidation, and deformation of materials by one atom or one molecule. He coined the term Nanotechnology. After Norio Taniguchi work, an American Engineer, **K. Eric Drexler**, best known for

the development of molecular nanotechnology, leading to nanosystems machinery manufacturing. **Heinrich Rohrer** was a Swiss Physicist who shared half of the 1986 Nobel prize in physics with Gerd Binning for the design of the Scanning Tunneling Microscope (STM). **Prof. C.N. Rao** an Indian Chemist is the one who synthesize Y junction Carbon Nanotubes and is known as father of Indian Nanotechnology.

Nanoparticles: -

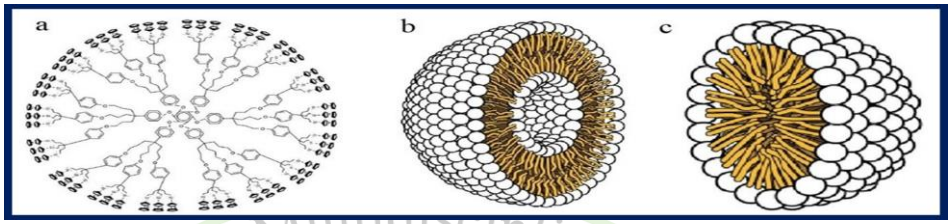
Nanoparticles or ultrafine particles is usually defined as a particle of matter that ranges between 1 and 100 nanometer (nm) in diameter. Nanoparticles possesses a great potential in targeted delivery of nutrients to living systems.

Classification of Nanoparticles: -

1. **On the basis of Chemical Composition: -**

A. Organic Nanoparticles (NPs):-

On the nanoscale, organic compounds are converted into organic nanomaterials. Some examples of organic nanoparticles or polymers are dendrimers, liposomes and micelles. Non-toxic biodegradable nanoparticles known as nano capsule micelles and liposomes have hollow interiors and are sensitive to heat, electromagnetic radiation, and light (Khan *et al.*, 2022). The surface of a dendrimers is coated with numerous chain ends that can perform specific chemical reactions. Dendrimers are used in molecular recognition, nano sensing, light harvesting, and opt electrochemical systems.



B. Inorganic Nanoparticles (NPs):-

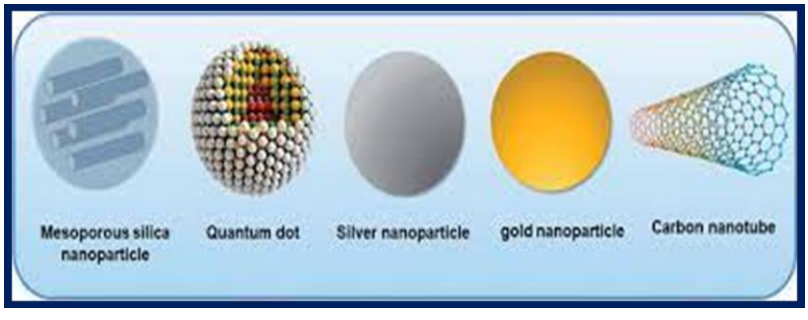
Inorganic nanoparticles are nanoparticles that lack carbon atoms and are known as inorganic nanoparticles. Inorganic nanoparticles are typically classified as those composed of metal-based or metal oxide-based nanomaterials.

(i) Metal-based nanoparticles: -

Metal-based nanoparticles can be synthesized through destructive or constructive processes. Aluminum (Al), cadmium (Cd), cobalt (Co), copper (Cu), gold (Au), iron (Fe), lead (Pb), silver (Ag), and zinc (Zn) are metal materials that are frequently used in nanoparticle synthesis. Because of their quantum effects and huge surface-to-volume ratio, metal nanoparticles have excellent ultraviolet-visible sensitivity, as well as electrical, catalytic, thermal, and antibacterial properties.

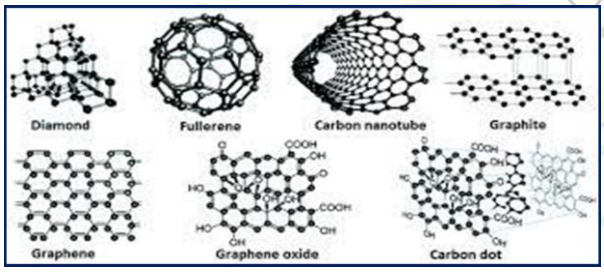
(ii) Metal oxide nanoparticles: -

Metal oxide nanoparticles, are composed of positive metallic ions and negative oxygen ions. Examples of metal oxide nanoparticles that are frequently synthesized include silicon dioxide (SiO_2), titanium oxide (TiO_2), zinc oxide (ZnO), and aluminum oxide (Al_2O_3).



C. Carbon based Nanoparticles (NPs):-

Carbon-based nanomaterials are composed of carbon include five main materials, namely, carbon nanotubes, Graphene, fullerenes, Carbon Nano fiber and Carbon black. **Fullerenes** are the spherical structure with diameters up to 8.2 nm for a single layer and from 4 to 36 nm for multi-layered fullerenes, which form from 28 to 1500 carbon atoms. **Graphene** is a hexagonal network of honeycomb lattices made up of carbon atoms on a two-dimensional (2D) planar surface, with the sheet around 1 nm, whereas cylindrical ones are described as nanotubes. Hollow cylinders to form nanotubes with diameters as low as 0.7 nm for a single-layered and 100 nm for a multi-layered **carbon nanotube** and lengths varying from a few micrometers to several millimeters, the same Graphene Nano fossils are used to produce **carbon Nano fiber**, and an amorphous material made up of carbon, generally spherical in shape, with diameters from 20 to 70 nm is known as **carbon black** (Khan and Hossain 2022, Cho *et al*., 2019).



2. On the basis of Origin: -

A. Natural Nanoparticles (NPs):-

Natural nanomaterials can be found in a variety of forms in nature, including viruses, protein molecules, minerals like clay, natural colloids like milk and blood (liquid colloids), fog (aerosol type), gelatin (gel type), mineralized natural materials like shells, corals, and bones, insect wings and opals, spider silk, lotus leaves, gecko feet, volcanic ash, and ocean spray.

B. Incidental Nanoparticles (NPs):-

Carbon nanotubes and semiconductor nanoparticles like quantum dots (QDs) are examples of artificial nanomaterials that are made consciously using precise mechanical and manufacturing procedures. Nanomaterials are categorized as metal-based materials, dendrimers, or composites depending on their structural makeup (Ahmad *et al*., 2023).

<u>Synthesis of Nanoparticles (NPs):-</u>

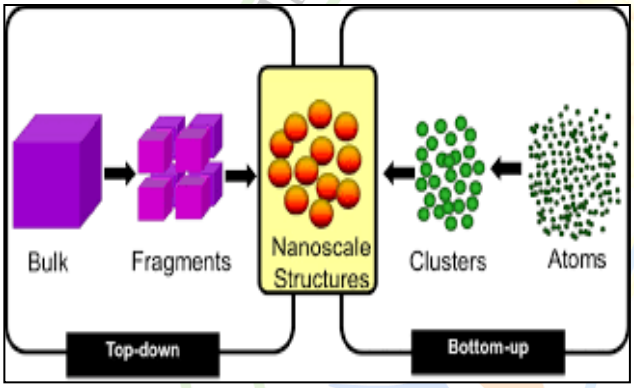
TOP-DOWN APPROACH

The top-down method, also known as a destructive method, decomposes bulk materials into smaller materials, which then transform into nanomaterials. Lithography, mechanical milling or ball milling, laser

ablation, sputtering, electron explosion, arc discharge, and thermal decomposition are examples of the top-down method (Patil *et al*., 2021).

BOTTOM-UP APPROACH

The bottom-up method, also known as the constructive method, involves the building of material from atoms to clusters to nanoparticles. CVD, sol-gel, spinning, pyrolysis, and biological synthesis are all examples of bottom-up methods (Baig *et al*., 2021).



References:

Khan, S., & Hossain, M. K. 2022. Nanoparticle-Based Polymer Composites. *Woodhead Publishin*, 15-54.

Khan, Y., Sadia, H., Shah, A.Z.S., Khan, N.M., Shah, A.A., Ullah, F., Ullah, F.M., Bibi, H., Bafakeeh, T.O., Khedher, B.N., Eldin, M.S., Fadhl, M.B. and Khan, I.M. 2022. Classification, synthetic and characterization approaches to nanoparticles and their applications in various fields of nanotechnology: A review. *Catalysts*, **12**(11): 1386.

Cho, G., Park, Y., Hong, K.Y. and Ha, H.D. 2019. Ion exchange: an advanced synthetic method for complex nanoparticles, **6**(17).

Ahmad, W., Singh, A., Singh, V., Mishrwan., Joshi, S. and Rawat, A. 2023. Titanium Dioxide Nanomaterials: Synthesis and Applications. *Asian Journal of Chemistry*, **35**(8): 1770- 1774.

Baig, N., Kammakakam, I. and Falath, W. 2021. Nanomaterials: a review of synthesis methods, properties, recent progress, and challenges. *Materials Advances*, 6.

Patil, N., Bhaskar, R., Vyavhare, V., Dhadge, R., Khaire, V. and Patil, Y. 2021. Overview on methods of synthesis of nanoparticles. *International journal of Current Pharmaceutical Research*, **13**(2).